The Role of Benefit-Cost Analysis in Integrated Grid Planning

Illinois

Multi-Year Integrated Grid Plan Workshops

Tim Woolf
Synapse Energy Economics
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Overview

Discuss key BCA concepts in the context of integrated grid planning in Illinois.

- National Standard Practice Manual for BCA of DERs
- The role of BCA in regulatory settings, including distribution system planning
- The choice of BCA test for distribution system planning
- BCA versus least-cost, best-fit analyses in distribution planning
- Key BCA issues for distribution planning in Illinois:
  - Minimize total system costs
  - Cost-effectiveness, including environmental goals
  - Affordability
  - Energy equity

National Standard Practice Manual

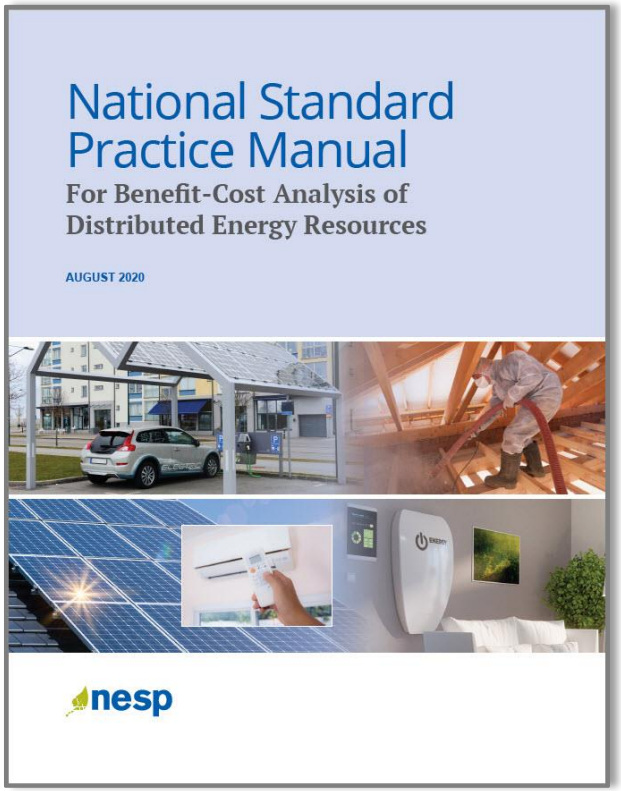
The National Energy Screening Project (NESP) is a stakeholder organization working collaboratively to improve cost-effectiveness screening practices for energy efficiency and other distributed energy resources.

Products include:

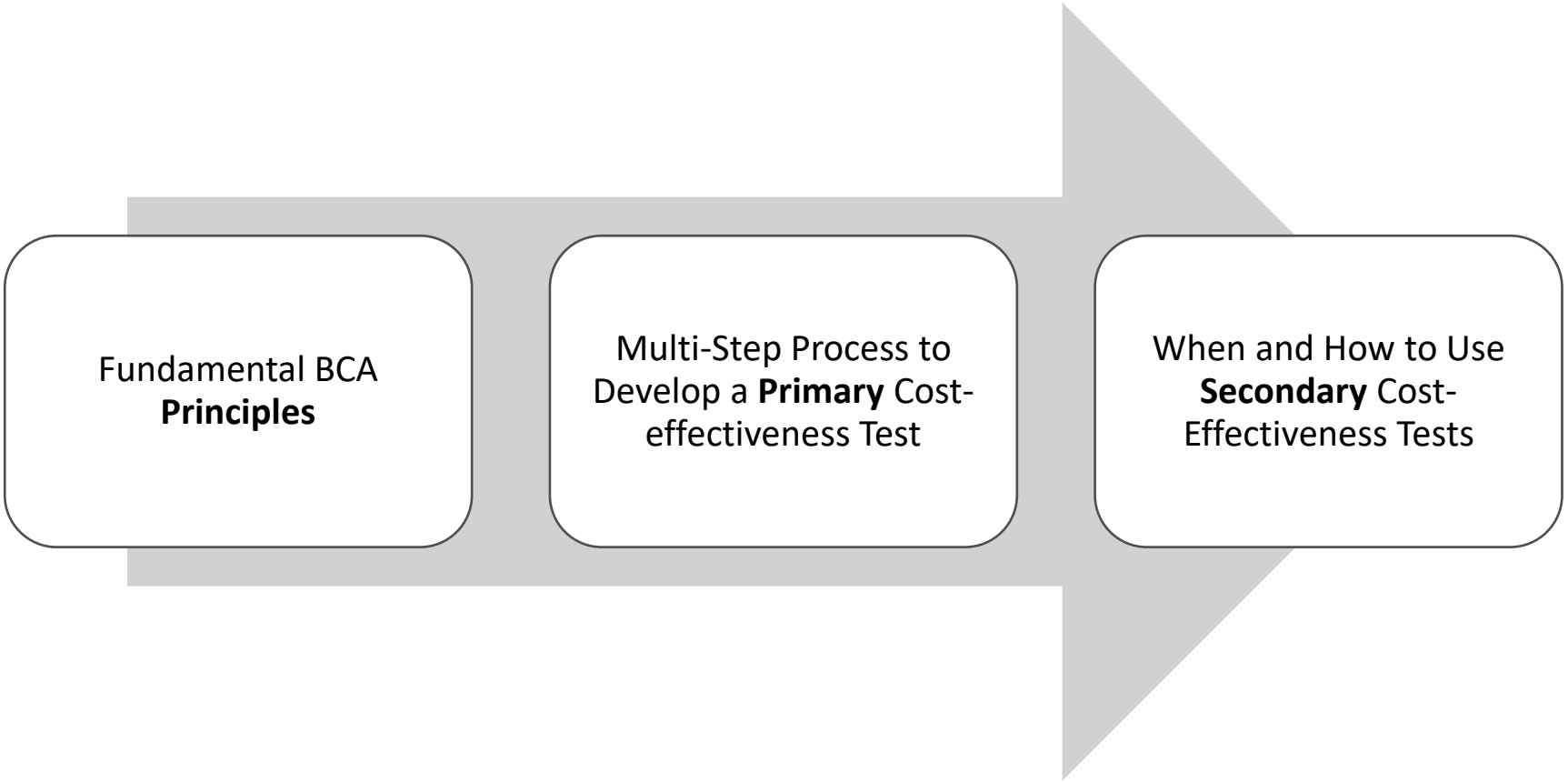
- NSPM for EE (2017)
- NSPM for DERs (2020)
- Methods, Tools, and Resources: A Handbook for Quantifying DER Impacts for BCAs
- Database of Screening Practices (DSP)

NESP work is managed by E4TheFuture.
NESP work is funded by E4TheFuture and in part by US DOE.

NSPM Website:
https://nationalenergyscreeningproject.org/



NSPM BCA Framework

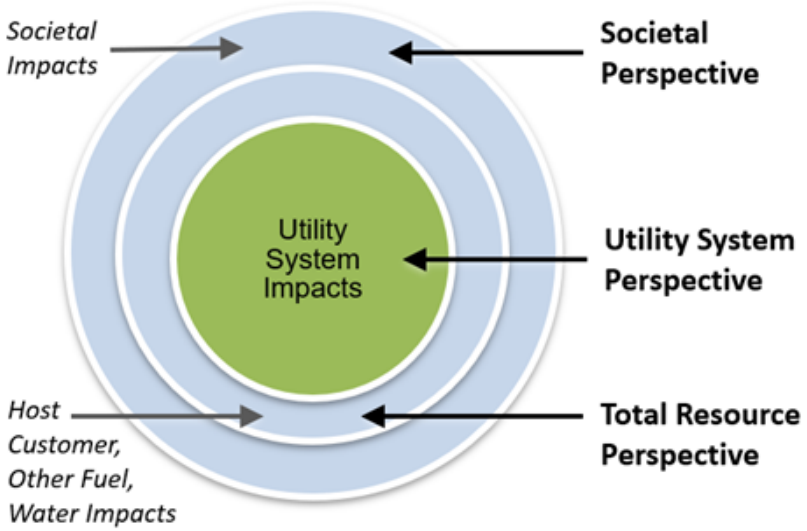


NSPM BCA Principles

1. Recognize that DERs can provide energy/power system needs and should be **compared with other energy resources** and treated **consistently** for BCA.
2. Align primary test with jurisdiction's **applicable policy goals**.
3. Ensure **symmetry** across costs and benefits.
4. Account for **all relevant, material impacts** (based on applicable policies), even if hard to quantify.
5. Conduct a **forward-looking, long-term** analysis that captures incremental impacts of DER investments.
6. Avoid **double-counting** through clearly defined impacts.
7. Ensure **transparency** in presenting the benefit-cost analysis and results.
8. Conduct **BCA separate from Rate Impact Analyses** because they answer different questions.

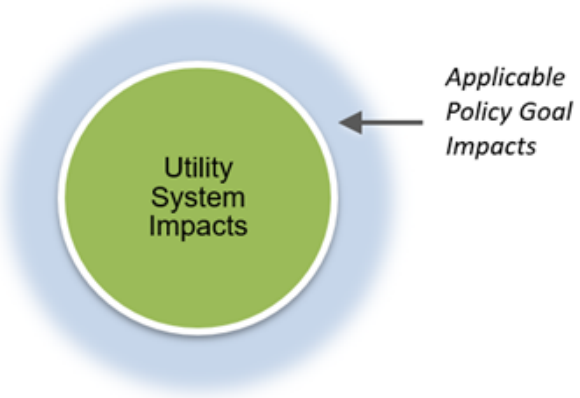
The Regulatory Perspective

Traditional Perspectives



- Three perspectives define the scope of impacts to include in the most common traditional cost-effectiveness tests.

Regulatory Perspective



- Perspective of public utility commissions, legislators, muni/coop boards, public power authorities, and other relevant decision-makers.
- Accounts for utility system plus impacts relevant to a jurisdiction's applicable policy goals (which may or may not include host customer impacts).
- Can align with one of the traditional test perspectives, but not necessarily.

5-Step Process for Defining a Primary BCA Test

STEP 1 **Articulate Applicable Policy Goals**

Articulate the jurisdiction's applicable policy goals related to DERs.

STEP 2 **Include All Utility System Impacts**

Identify and include the full range of utility system impacts in the primary test, and all BCA tests.

STEP 3 **Decide Which Non-Utility System Impacts to Include**

Identify those non-utility system impacts to include in the primary test based on applicable policy goals identified in Step 1:

- Determine whether to include host customer impacts, low-income impacts, other fuel and water impacts, and/or societal impacts.

STEP 4 **Ensure that Benefits and Costs are Properly Addressed**

Ensure that the impacts identified in Steps 2 and 3 are properly addressed, where:

- Benefits and costs are treated symmetrically;
- Relevant and material impacts are included, even if hard to quantify;
- Benefits and costs are not double-counted; and
- Benefits and costs are treated consistently across DER types

STEP 5 **Establish Comprehensive, Transparent Documentation**

Establish comprehensive, transparent documentation and reporting, whereby:

- The process used to determine the primary test is fully documented; and
- Reporting requirements and/or use of templates for presenting assumptions and results are developed.

The Jurisdiction Specific Test (JST)

Test	Perspective	Key Question Answered	Categories of Benefits and Costs Included
Jurisdiction-Specific Test	Regulators, i.e., decision-makers	Will the cost of meeting utility system needs, *while achieving applicable policy goals,* be reduced?	Includes the utility system impacts, and those impacts associated with achieving applicable policy goals
Utility Cost Test*	The utility system	Will utility system costs be reduced?	Includes the utility system impacts
Total Resource Cost Test	The utility system plus host customers	Will utility system costs and host customers' costs collectively be reduced?	Includes the utility system impacts, and host customer impacts
Societal Cost	Society as a whole	Will total costs to society be reduced?	Includes the utility system impacts, host customer impacts, and societal impacts such as environmental and economic development impacts

*Also referred to as Program Administrator Cost Test (PACT)

The JST Relative to Other Tests

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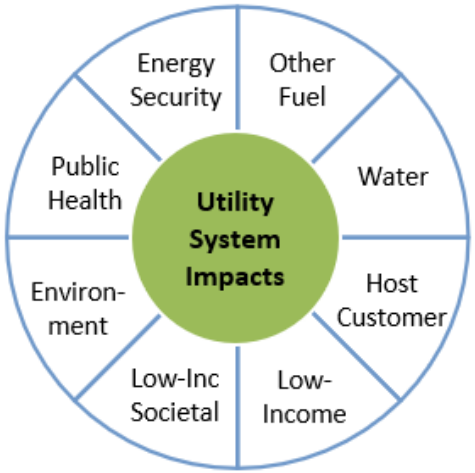
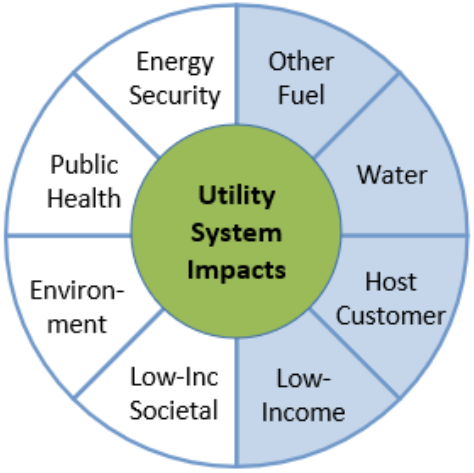
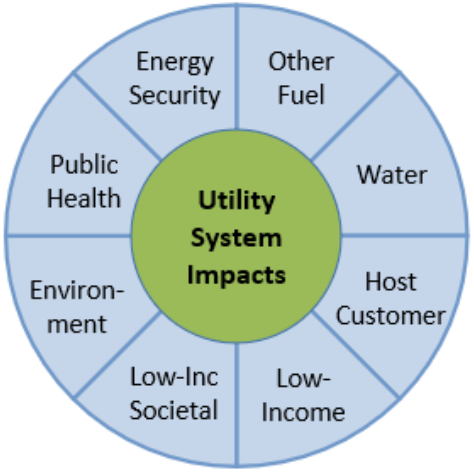
JST 1 = UCT/PACT



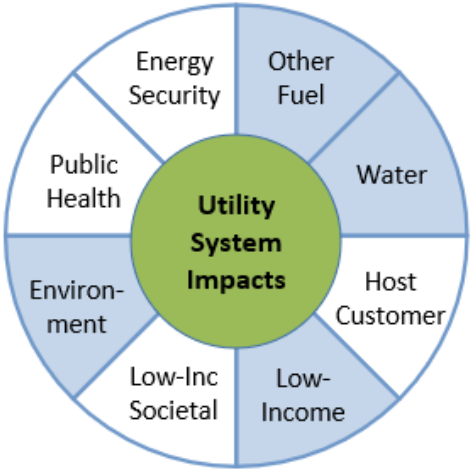
JST 2 = TRC Test



JST 3 = SCT



JST 4 ≠ traditional CE test *



UCT = Utility Cost Test (or PACT = Program Admin Cost Test)
TRC = Total Resource Cost Test
SCT = Societal Cost Test

All utility system impacts included

Non-utility system impacts included

Non-utility system impacts *not* included

*JST 4 includes a different set of non-utility system impacts based on *its applicable policies.*

JSTs may or may not align with traditional tests.

BCAs and Rate Impact Analyses

The two analyses answer different questions

	Benefit-Cost Analysis	Rate Impact Analysis
Purpose	To identify which DERs utilities should invest in or otherwise support on behalf of their customers	To identify how DERs will affect rates, in order to assess equity concerns
Questions Answered	What are the future costs and benefits of DERs?	Will customer rates increase or decrease, and by how much?
Results Presented	• Cumulative costs (PV$) • Cumulative benefits (PV$) • Cumulative net benefits (PV$) • Benefit-cost ratios	• Rate impacts (c/kWh, %) • Bill impacts ($/month, %) • Participation rates (#, %)

Very Different Information

The Rate Impact Measure (RIM) Test is sometimes used for BCA purposes. However, it combines the two analyses and therefore makes it difficult to answer either question

The Role of BCA in Different Regulatory Settings

Context	Application	Goal of BCA	Role of Costs & Benefits
Programs	EE, DR, DG, Storage, EVs	determine whether to implement the program	compare program benefits to costs
Procurement	DERs, NWAs, PPAs,	determine the ceiling price	ceiling price should equal the benefits of the procurement
Pricing	Rate design	estimate long-run marginal costs	long-run marginal costs should equal the benefits of modifying consumption
	DER compensation	determine the value of DER	value of DER is the sum of benefits
Planning	Optimize DERs	identify optimal DER portfolio	compare portfolio benefits to costs
	DP, IDP, IRP, IGP	identify preferred resource scenario	compare scenario benefits to costs
	GHG plans	achieve GHG goals at low cost	compare GHG plan benefits to costs
	State Energy Plans	identify resources to meet state goals	compare state plan benefits to costs
Infrastructure Investments	Grid Mod, AMI, EV infrastructure, etc.	determine whether to make the investment	compare investment benefits to investment costs
Prudence Reviews	Retrospective review	determine whether past utility decision was appropriate	compare benefits and costs using test in place at the time the decision was made
	Prospective review	determine whether proposed utility decision is appropriate	compare benefits and costs using test currently in place

Choice of BCA Test for Distribution Planning

- The same principles and concepts used to develop BCA tests for DERs should be used to develop BCA tests for distribution planning
- The same primary test (i.e., Jurisdiction Specific Test) used for DERs should be used for distribution planning
- Otherwise, you can end up with uneconomic outcomes
- For example:
  - If a Total Resource Cost test is used for DERs
  - And a Societal Cost test for is used for distribution planning
  - Then the DER planning results will not reveal some of the DERs that might be useful in reducing societal impacts in the distribution planning process

BCA Tests for DERs and Distribution Planning

Impact	Perspective	DER BCA (from the NSPM for DERs)	Distribution Planning BCA (hypothetical)
Costs	Utility System	· customer incentives · program administration · utility incentives · equipment costs	· capital costs · O&M costs · ancillary service costs · equipment costs
	Affected Customers	· measure costs · non-energy costs · other fuel costs	· none
	Society	· environmental · economic development · other	· environmental · economic development · other
Benefits	Utility System	· energy · capacity · ancillary services · T&D, T&D losses · credit & collection · reliability & resilience	· energy · capacity · ancillary services · T&D losses · O&M · reliability & resilience
	Affected Customers	· non-energy benefits · other fuel savings · reliability &resilience	· reliability &resilience
	Society	· environmental · reliability & resilience · economic development · other	· environmental · reliability & resilience · economic development · other

BCA and Least-Cost Best-Fit

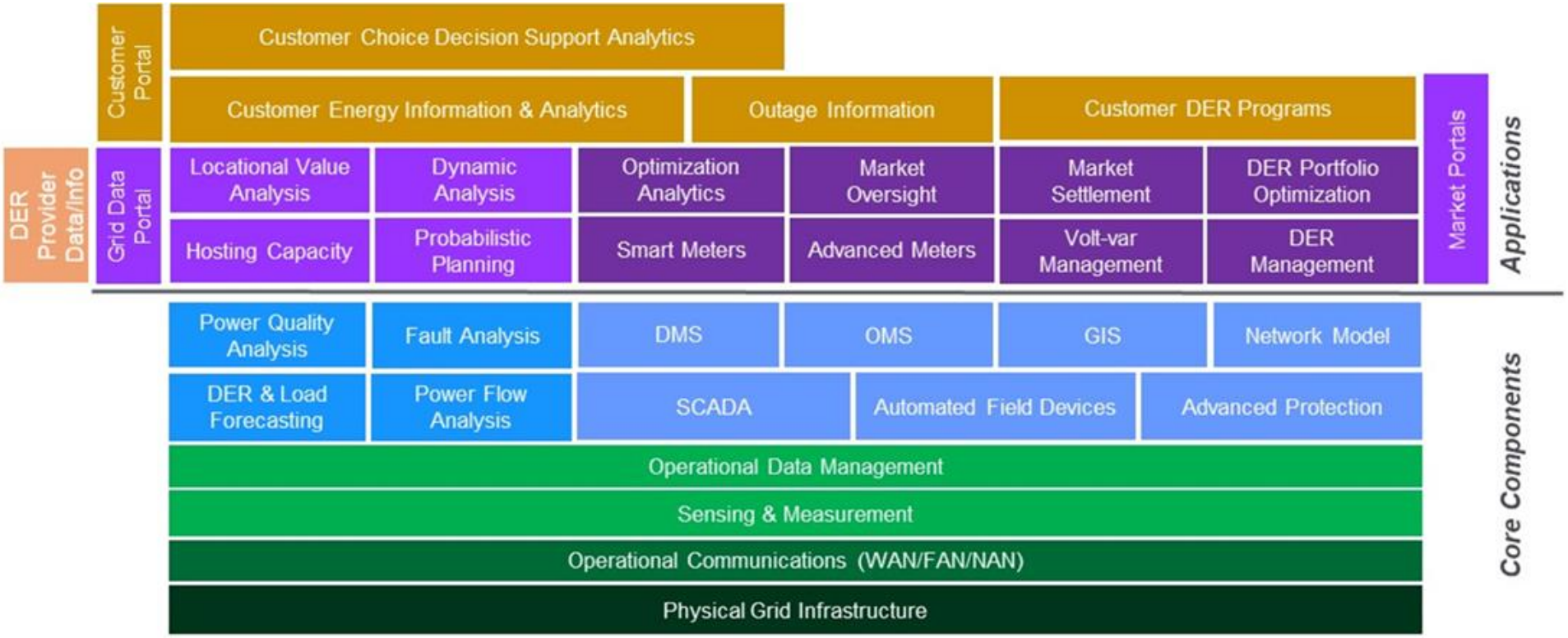
	Definition	Application	Costs	Benefits
BCA	To identify the net benefits of a proposed investment/resource.	To determine whether to pursue the proposed investment/resource.	Included. Extend of costs depends upon test chosen.	Included. Extend of benefits depends upon test chosen.
Least-Cost/ Best-Fit	To identify the investment/resource that meets needs at lowest cost.	For investments where the need has already been determined (e.g., a distribution line is needed for reliability)	Included. Typically includes only utility system costs.	Not included. Benefits are presumed to be worth the costs.

BCA Versus Least-Cost Best-Fit

- The main difference is that LCBF does not require estimates of benefits – it is presumed that the investment is needed.
  - For years, this approach has been sufficient for distribution planning because it was applied to investments that were needed to maintain reliability.
- A BCA provides much more information than LCBF.
  - BCA provides certainty as to whether benefits exceed costs.
- LCBF should be used only when necessary.
  - Because it does not provide detail on the benefits.
- Deciding when to use LCBF.
  - Are there a lot of benefits that are not monetizable? Maybe use LCBF.
  - Is the investment needed for reliability or resilience? Maybe use LCBF.
  - Is the investment needed to meet regulatory policy goals? BCA is preferable.
  - Is the investment considered a core or platform? Maybe use LCBF.
- Non-monetized benefits should be accounted for as much as possible.
  - Regardless of whether BCA or LCBF is used.

Source: DOE Grid Mod Laboratory Consortium, *Benefit-cost Analysis for Utility-Facing Grid Modernization Investments*, prepared by Synapse Energy Economics, February 2021.

Core Components Versus Applications



Source: US DOE 2017, *Modern Distribution Grid: Decision Guide,* Volume III, page 26, Figure 8.

Accounting for Non-Monetized Benefits

- Put as many benefits as possible in monetary terms.
- Define benefits in such a way that they can be monetized.
- Provide as much quantitative data as possible.
- Apply the least-cost, best-fit framework - where warranted.
  - This approach does not require monetization of benefits
- Establish metrics to assess benefits.
  - Metrics do not need to be in monetary terms
- Use quantitative methods to address non-monetized benefits:
  - use a point system to assign value to non-monetized benefits
  - assign proxy values for significant non-monetized benefits
  - use a weighting system to assign priorities to non-monetized benefits
  - use multi-attribute decision-making techniques

Source: DOE Grid Mod Laboratory Consortium, *Benefit-cost Analysis for Utility-Facing Grid Modernization Investments*, prepared by Synapse Energy Economics, February 2021.

The Goals of Integrated Grid Planning in Illinois

1. Achieve renewable energy, climate, and environmental goals.
2. **Minimize total system costs**.
3. Support grid modernization, clean energy, DERs.
   Bring at least **40% of the benefits to Equity** Investment Eligible Communities.
4. Customer engagement.
5. Reduce grid congestion.
6. Ensure robust public participation.
7. **Analyze cost-effectiveness** of proposed investments;
   accounting for environmental costs and benefits.
8. Achieve Illinois environmental goals.
9. Promote energy efficiency, demand response, and renewables
10. Provide information to support DER adoption.
11. Deliver services at **rates that are affordable to all customers**, including low-income.

Source: Illinois Multi-Year Integrated Grid Planning Regulations, Section 475.100(e).

Minimize Total System Costs

- The Utility Cost Test (UCT) is the best BCA test for determining how to minimize total system costs.
- The UCT should include all costs and benefits that affect utility revenue requirements; generation, transmission, distribution, ancillary services:
  - Capital costs & benefits
  - O&M costs & benefits
  - Equipment costs & benefits
  - Etc.
- Note that the UCT does not account for several energy policy goals.
- All the costs and benefits of the UCT also feed into the rate impact analysis.
- The UCT could be used as a secondary test for Grid Planning in Illinois.

Accounting for Environmental Costs and Benefits

Environmental costs and benefits could be included in the primary BCA test in Illinois.

It is important to distinguish between:

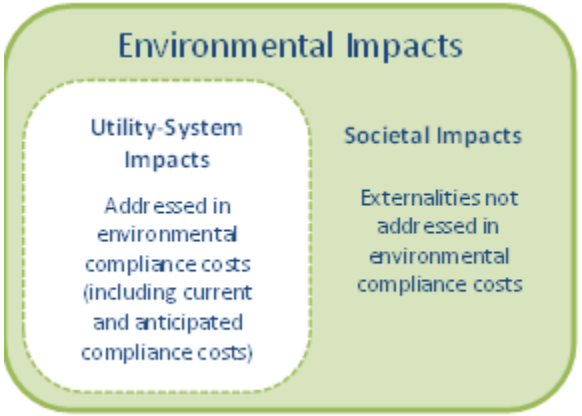
- The environmental compliance costs, which are part of the utility system impacts and will affect rates.
- The societal environmental impacts, which are externalities and will not affect rates.

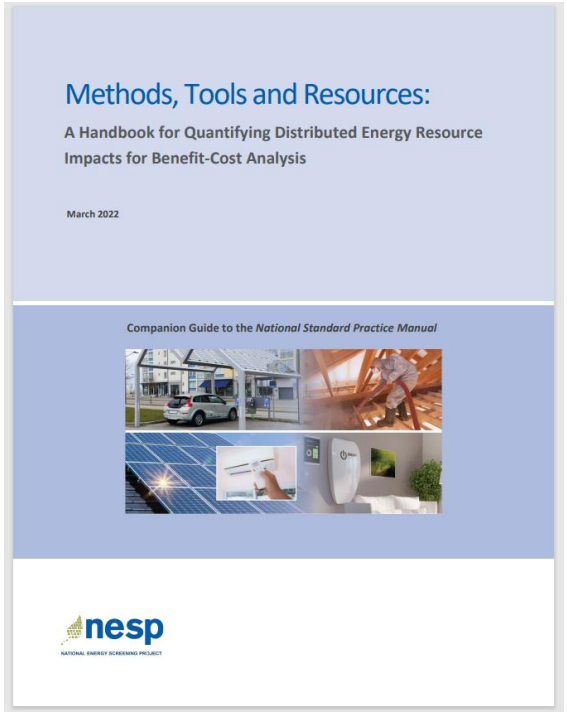
The cost of compliance with environmental regulations should account for future, as well as current, environmental requirements.

Two key methods for estimating GHG impacts:

- Social cost of carbon method
- Marginal abatement cost method

Methods to account for environmental costs and benefits are described in the NESP Methods, Tools, and Resources Handbook.





Affordability, Including Low-Income Customers

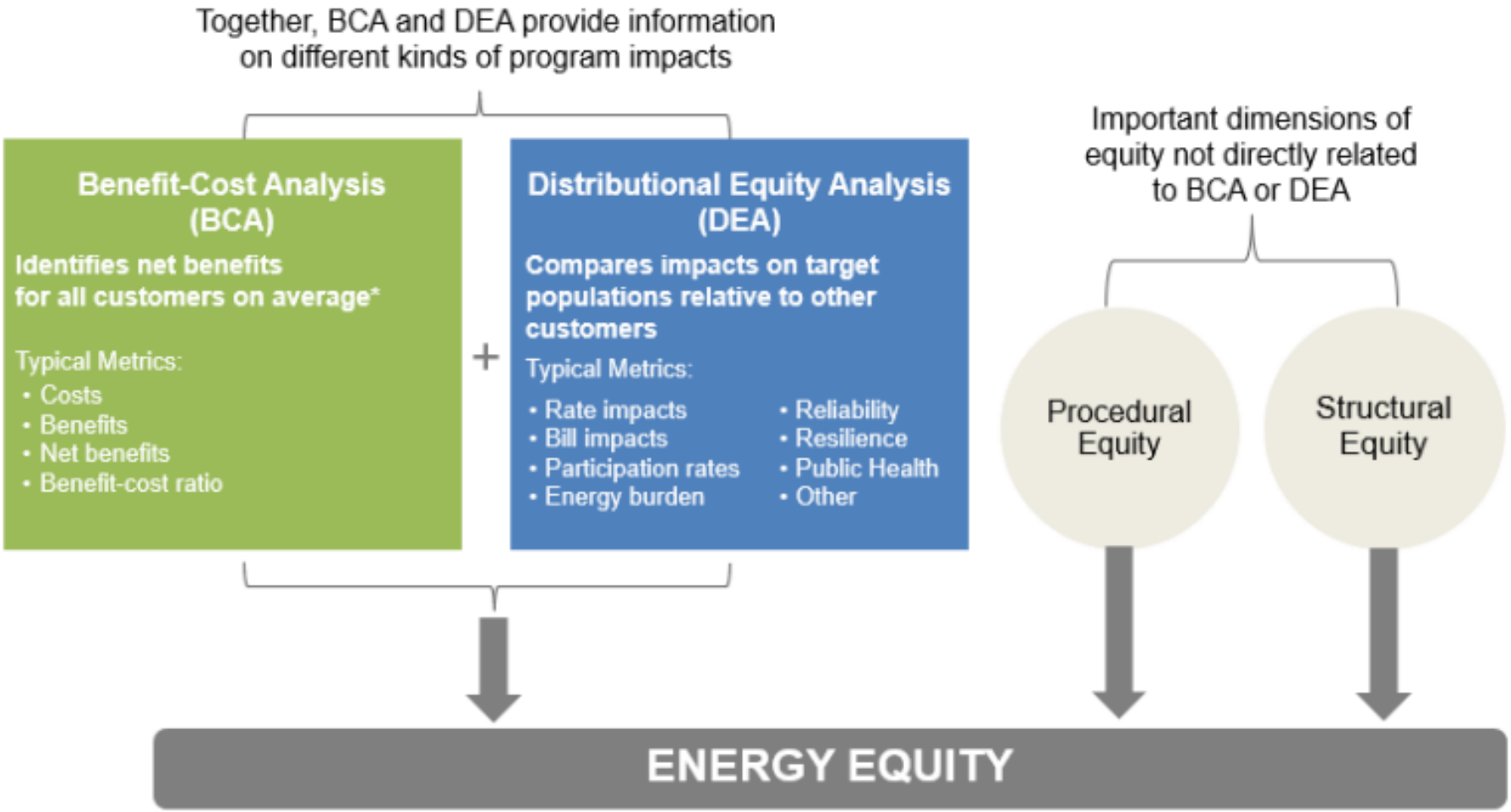
One of the best ways to promote affordability, for all customers, is to minimize total system costs (see slide #19).

Another way to assess affordability is a comprehensive, rate, bill, and participation analysis:

- **Rate impacts**, provide an indication of the extent to which rates for all customers might change.
- **Bill impacts**, provide an indication of the extent to which customer bills might change.
- **Participation impacts**, provide an indication of the portion of customers that will experience bill reductions or bill increases.
- Taken together, these three impacts help assess equity issues.

- Rate, bill, participation analyses can be conducted for low-income customers, and for other vulnerable customers.

Equity in the Context of BCA



Source: NESP, *Methods, Tools, and Resources: A Handbook for Quantifying DER Impacts for BCAs*, March 2022.

Equity in the Context of Distribution Planning

Questions to assess equity issues:

1. Is this the lowest cost plan for the desired outcomes?
    - BCA and LCBF help answer this question.
2. What are the long-term bill impacts of the plan?
    - Including impacts on vulnerable customers.
3. Does the plan provide equitable reliability and resilience benefits?
    - Especially for vulnerable customers and communities.
    - Have these customers received equitable services in the past?
    - Does the proposed plan improve or worsen reliability or resilience for them?
4. Does the plan provide equitable access to DERs & grid services
    - Especially for vulnerable customers and communities

Questions and Answers

Contact Information

Synapse Energy Economics
is a research and consulting firm specializing in technical analyses of energy, economic, and environmental topics. Since 1996 Synapse been a leader in providing rigorous analysis of the electric power and natural gas sectors for public interest and governmental clients.

Tim Woolf
Senior Vice-President
Synapse Energy Economics
617-453-7031
twoolf@synapse-energy.com
www.synapse-energy.com

Appendix

Appendix

Components of BCA and Rate Impact Analyses

	Include in Benefit-Cost Analysis	Include in Rate Impact Analysis
Utility system impacts	✓	✓
Host customer impacts	depends on policy goals	do not affect rates
Social impacts	depends on policy goals	do not affect rates
Lost revenues	do not affect costs	✓
Increased revenues	do not affect costs	✓
Net metering bill credits	do not affect costs	✓

See NSPM for DERs Appendix A on Rate Impact Analyses

Rate, Bill and Participant Impacts

A thorough understanding of rate impacts requires an analysis of three important factors:

- **Rate impacts**, provide an indication of the extent to which rates for all customers might increase.
- **Bill impacts**, provide an indication of the extent to which customer bills might be reduced for those customers that install DERs.
- **Participation impacts**, provide an indication of the portion of customers that will experience bill reductions or bill increases.
    - Participation impacts are also key to understanding the extent to which customers are adopting DERs based on DER policies.

Consider Both BCA and Rate Impact Analyses

Illustrative example: Energy Efficiency Portfolio

Sometimes it is necessary to make tradeoffs between reduced costs and higher rates.

Benefit-Cost Analysis	Net Benefits (mil PV$)	85
	Benefit-Cost Ratio	2.1
Rate Impact Analysis	Rate Impacts (%)	1.3
	Bill Impacts Participants (%)	-3.4
	Participation Rate (%) Participation Low-Income (%)	68 56
Additional Considerations	GHG Goal Achieved (%)	28

← significant net benefits...

← but rates increase...

← but many customers participate and see lower bills.

← and there is a big impact on key policy goal

Consider Both BCA and Rate Impact Analyses

Illustrative Example: Demand Response Portfolio

Sometimes there are no tradeoffs.

Benefit-Cost Analysis	Net Benefits (mil PV$)	15
	Benefit-Cost Ratio	1.4
Rate Impact Analysis	Rate Impacts (%)	-0.1
	Bill Impacts Participants (%)	-1.2
	Participation Rate (%) Participation Low-Income (%)	24 13
Additional Considerations	GHG Goal Achieved (%)	3

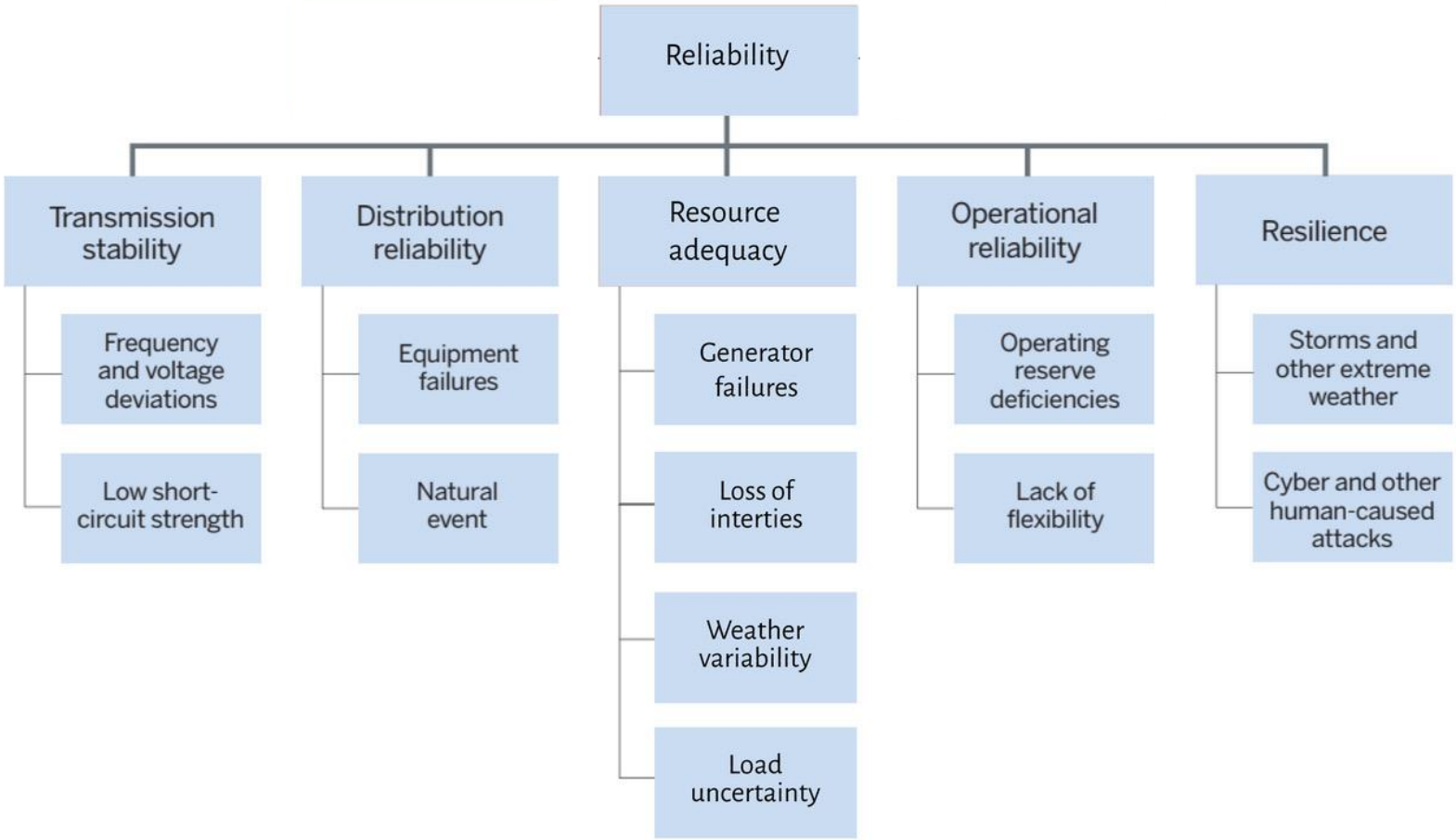
some net benefits...

and rates decrease...

but fewer customers participate...

and not much impact on key policy goal

Reliability and Resilience



Source: JP Carvallo, *Quantifying Reliability and Resilience Impacts of Energy Efficiency: Examples and Opportunities*, presented at the ACEEE Energy Efficiency as a Resource Conference, October 26, 2021.

Reliability and Resilience

Reliability

- The ability of the system or its components to prevent or withstand instability, uncontrolled events, cascading failures, or unanticipated loss of system components (US DOE)
- The ability of the system to deliver power in the face of routine uncertainty in operation conditions (LBNL)
- Metrics and methods are standardized and widely accepted

Resilience

- Robustness and recovery characteristics of utility infrastructure and operations, which avoid or minimize interruptions of service during an extraordinary and hazardous event (NARUC 2013).
- The ability of a power system and its components to withstand and adapt to disruptions and rapidly recover from them (US DOE 2013).
- The ability to withstand and reduce the magnitude and/or duration of disruptive events, which includes the ability to anticipate, absorb, adapt to, and/or rapidly recover from such an event (FERC 2018).
- The ability of the system and its components (i.e., both the equipment and human components) to minimize the damage and improve recovery from the non-routine disruptions, including high impact, low frequency events, in a reasonable amount of time" (NATF 2021).

Key distinction is that reliability pertains to routine events
while resilience pertains to extraordinary events

Key Steps for Assessing Reliability

1. Define reliability metrics.
2. Define and quantify baseline reliability.
   - The reliability for a Reference Case.
3. Characterize the potential reliability impacts of DERs.
   - These are different for different types of DERs, e.g., EE versus DR, versus PV, versus storage
4. Quantify the reliability impacts from the relevant DERs.
   - The reliability for a DER Case.
5. Calculate the net reliability impacts of the relevant DERs.
   - Difference between the Reference Case and the DER Case.
6. Methods for determining monetary value of improved reliability
   - Stated preferences
   - Revealed preferences
   - Quantitative models (e.g., the LBNL ICE model)

Reliability Metrics

Distribution System	System Average Interruption Duration Index (SAIDI)
	System Average Interruption Frequency Index (SAIFI)
	Customer Average Interruption Duration Index (CAIDI)
	Momentary Average Interruption Frequency Index (MAIFI)
	Customers Experiencing Multiple Interruptions (CEMI)
	Customers Experiencing Longest Interruption Duration (CELID)
Transmission System	N-1 analysis
	Loss-of-Load Probability (LOLP)
	Loss-of-Load Expectation (LOLE)
System-Wide Metrics	Planning Reserve Margin
	Effective Load Carrying Capacity (ELCC)
	LOLP and LOLE
Monetary	Value of Lost Load (VOLL)
	Customer Interruption Costs (CIC)
	Service Restoration Costs

Key Steps for Assessing Resilience

1. Characterize the threats.
2. Define reliability metrics.
3. Define and quantify baseline resilience.
4. Characterize the potential resilience impacts of DERs.
5. Quantify the resilience impacts from the relevant DERs.
6. Calculate the net resilience impacts of the relevant DERs.

These four steps are essentially the same steps used for reliability

7. Methods for determining monetary value of improved resilience.
   - Some of the same methods used for reliability can be used for resilience
   - Additional methods are needed
     - For example, how to customer interruption costs differ for routine outages relative to extraordinary outages?

Resilience Metrics

Impact	Consequence Category	Resilience Metrics
DIRECT	Electric Service	Cumulative customer-hours of outages
		Cumulative customer energy demand not served
		Average number (or %) of customers experiencing an outage during a specified time
	Critical Electrical Service	Cumulative critical customer-hours of outages
		Critical customer energy demand not served
		Average number (or %) of critical loads that experience an outage
	Restoration	Time to recovery
		Cost of recovery
	Monetary	Loss of utility revenue
		Cost of grid damages (e.g., repair or replace lines, transformers)
		Cost of recovery
		Avoided outage cost
INDIRECT	Community Function	Critical services without power (e.g., hospitals, fire stations, police stations)
	Monetary	Loss of assets and perishables
		Business interruption costs
		Impact on the gross municipal product (GMP) or gross regional product (GRP)
	Other Critical Assets	Key production facilities without power
		Key military facilities without power

Source: Institute of Electrical and Electronic Engineers (IEEE) 2021. Resilience Framework, Methods, and Metrics for the Electricity Sector, Bill Chiu. IEEE Technical Report PES-TR65. February 10, page 14

Reliability & Resilience

- Which perspectives do reliability and resilience affect?
  - Utility system perspective
  - Host customer perspective
  - All customer perspective
  - Societal perspective
  - All the above
- Does it matter?
- Maybe not
  - If a jurisdiction has a policy to improve reliability and resilience, then those impacts should be included in the JST.
  - For the purpose of describing and estimating reliability and resilience impacts, it is useful to categorize them.
  - For secondary tests, e.g., Utility Cost Test, it would be useful to categorize them.

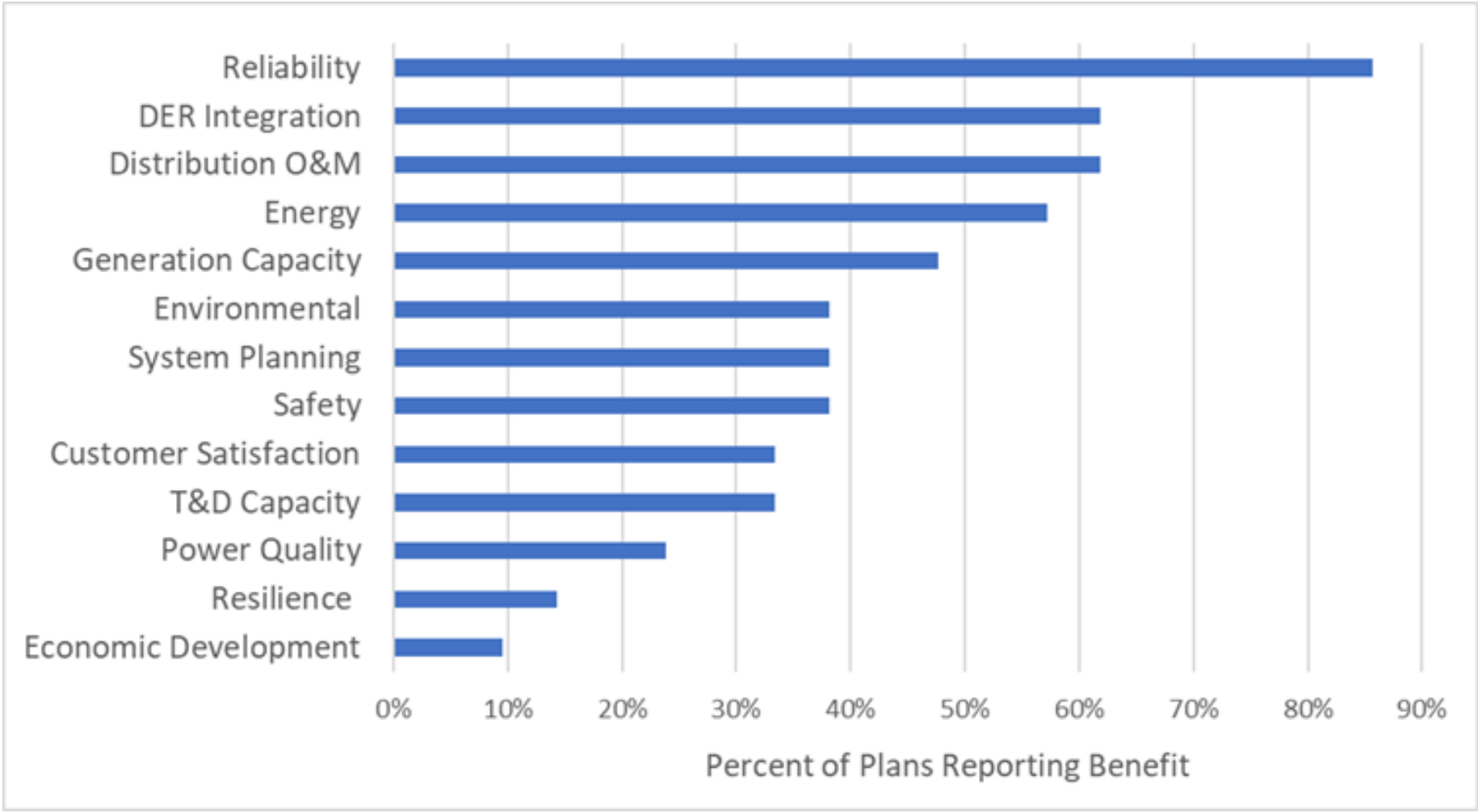
Review of Grid Mod Plans: General Themes

Key items that were generally lacking:

- An overarching rationale for grid modernization investments and an explanation of how individual components will help meet overall goals
- Identification of which cost-effectiveness test was used for the BCA
- Identification of which discount rate was used to determine present values
- Methodologies to account for the interdependencies of grid modernization components
- Methodologies to account for unmonetized benefits of grid modernization components
- Robust definitions of grid modernization metrics and how they will be used to monitor grid modernization costs and benefits over time
- Methodologies or discussions of how to address customer equity issues

Source: DOE Grid Mod Laboratory Consortium, *Benefit-cost Analysis for Utility-Facing Grid Modernization Investments*, prepared by Synapse Energy Economics, February 2021.

Type and Frequency of Claimed Benefits



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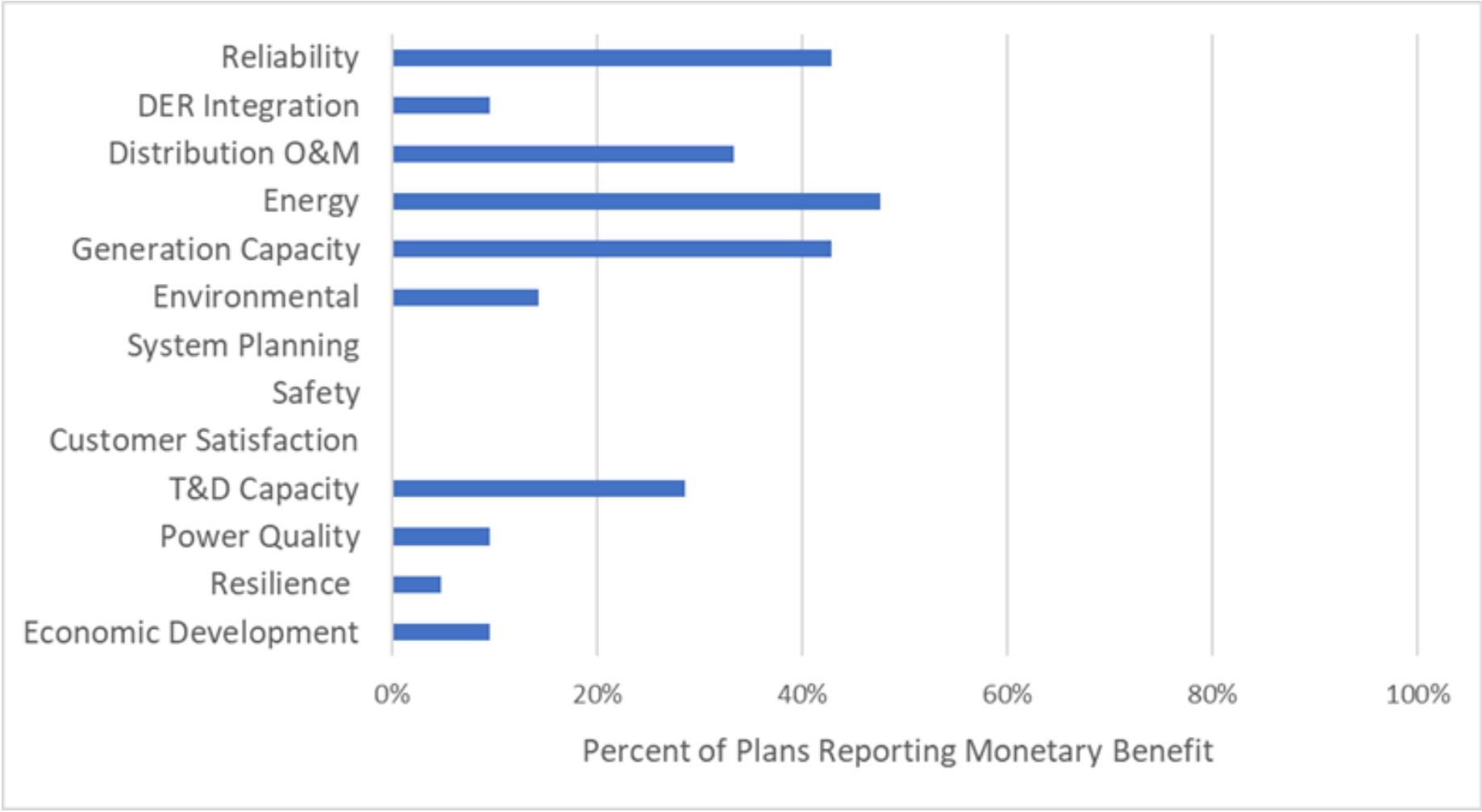
Type and Frequency of Monetized Benefits



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